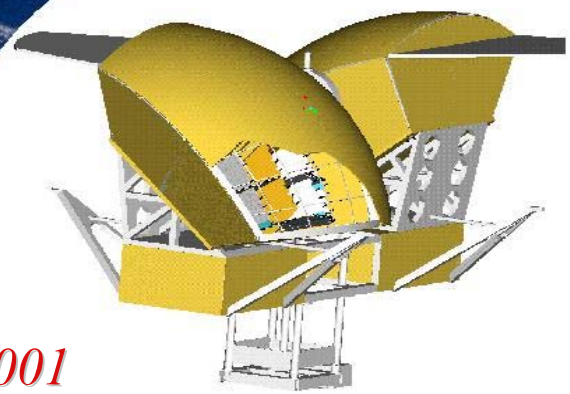
EXIST (Energetic X-ray Imaging Survey Telescope)



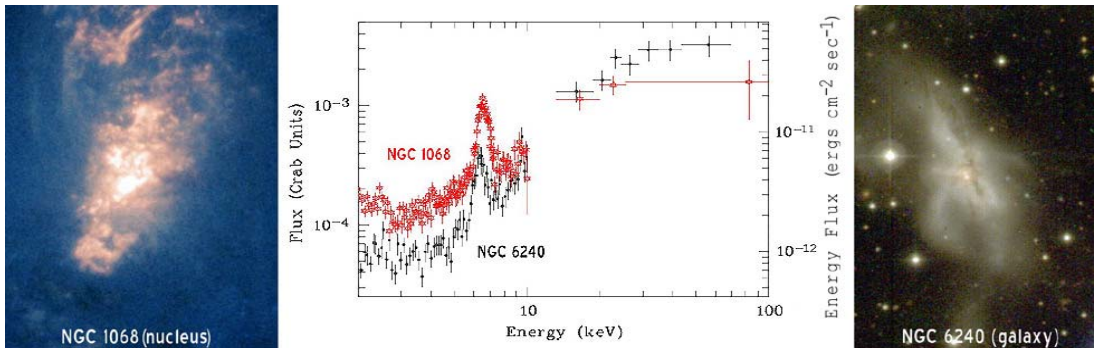
Josh Grindlay
CfA
Con-X/FST Meeting, May 4, 2001

(on behalf of EXIST Science Working Group: ***http://EXIST.gsfc.nasa.gov)***

Imaging the Hard X-ray Universe in Space/Time

EXIST conducts the deepest all-sky imaging HX Survey

•Obscured AGN and accretion history of universe



BeppoSAX on Seyfert 2's: EXIST reaches >30X deeper and full sky

•Survey black holes on all scales: BH content of Galaxy ➡ AGN

EXIST *is* the Next Generation GRB Mission

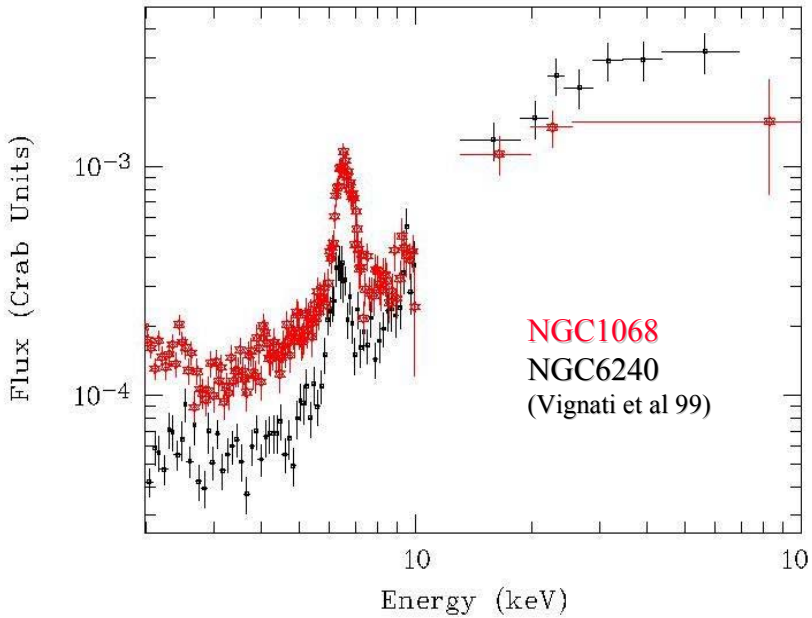
•Survey Gamma Ray Bursts to the limits (z~10-20; Δ*time;* Δ*energy*)

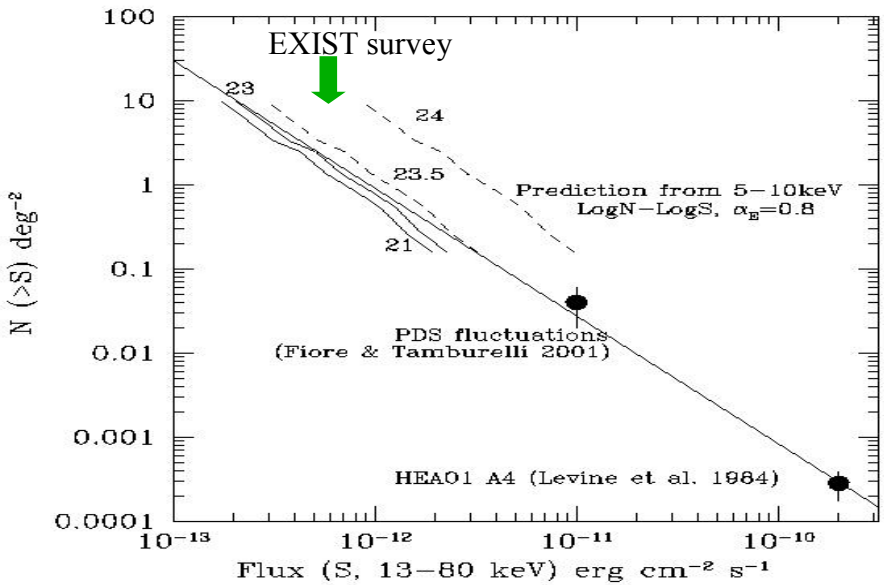
➡ *Formation of first massive stars (Pop III)*

•Soft Gamma Repeaters (to Virgo); transients, bursts, pulsars (Galaxy)

Key EXIST science: Obscured AGN

ASCA and **BeppoSAX** find highly absorbed Seyfert 2's and likely dominant contribution of absorbed AGN to cosmic x-ray background:





and **Chandra** deep surveys find blank field and optically-dull AGN

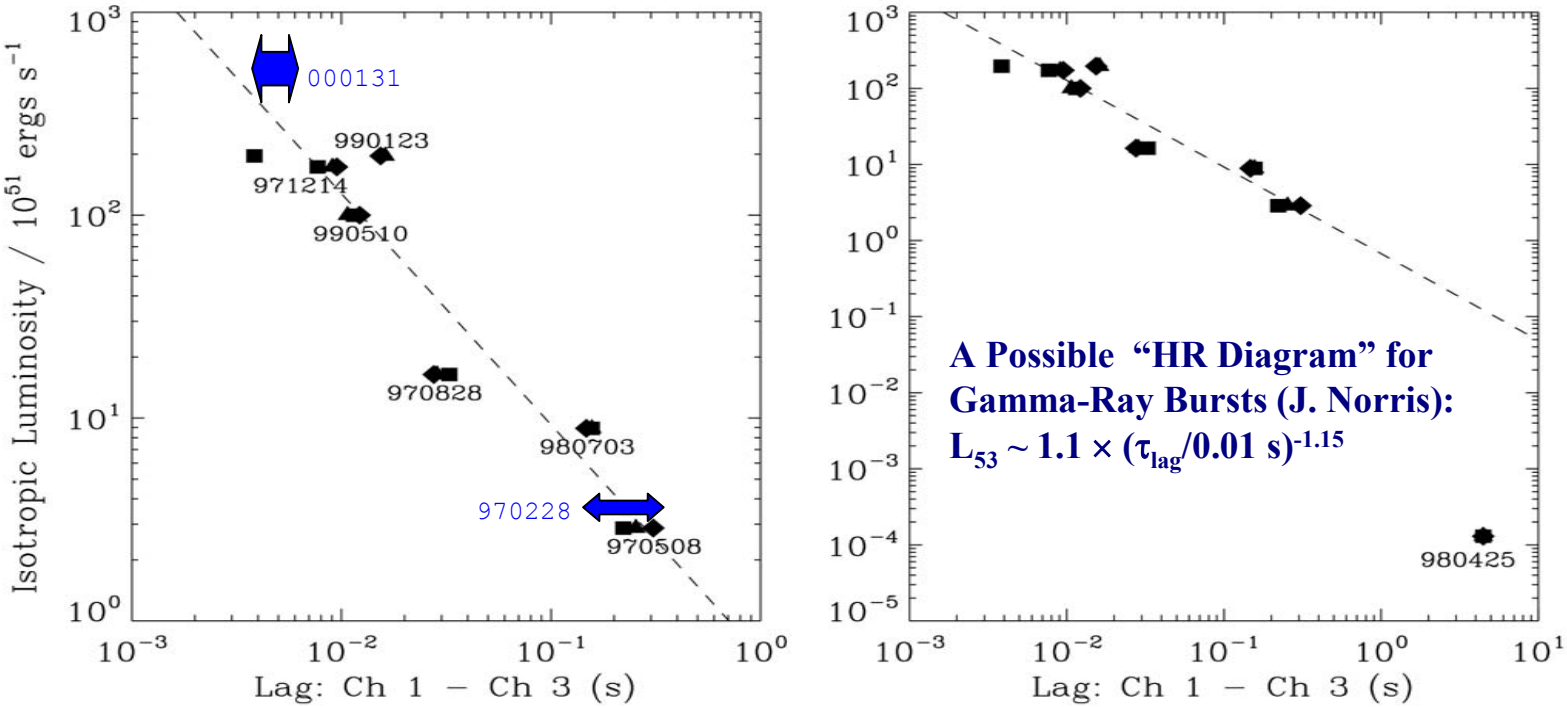
➡ **EXIST** will find >1-10 obscured AGN/square degree and obtain first all-sky measure of Seyfert 2 to QSO 2 luminosity function

EXIST identifies brightest (all sky) obscured AGN for Con-X

Key Science: GRB spectral evolution

GRBs have peak flux at ~100-300 keV but extend to >>500 keV.

- High time resolution spectra constrain source models & beaming
- Broad band spectral ***lags*** can constrain z (photometric redshifts):



EXIST will measure faintest GRBs over broadest spectral-temporal range (2-3 GRBs/day; 5-50" positions) as the Next Generation GRB Observatory

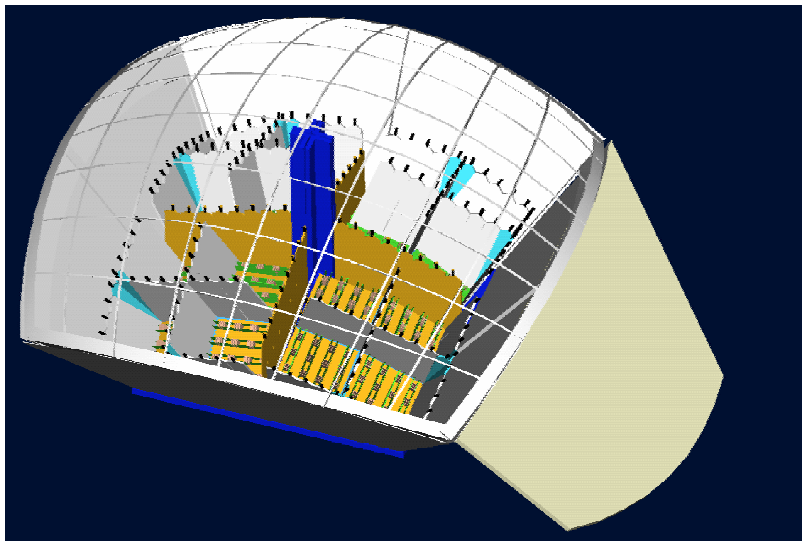
EXIST will locate most distant GRBs for Con-X spectra

EXIST Galactic Surveys/Triggers for Con-X

- **Supernova and Nova Rates in Galaxy: Stellar Death Rates:** *HXT images/ spectra*
  - **First map of entire Galaxy in 68,78 keV lines of ^{44}Ti: hidden SNR**
  - **All sky monitoring/imaging of 478,511 keV fast (~8h) line transients: nova rate**
- **Accretion onto Black Holes vs. Neutron Stars:** *SXT & HXT images/ spectra*
  - **Spectral variability: accretion instabilities and jet formation (e.g. μ-QSOs)**
  - **Survey for persistent HX sources in GMCs: ~10-100 Msun BHs or VMOs?**
  - **Long-term spin measures of accreting pulsars: magnetic accretion**
- **Magnetic Fields of Neutron Stars:** *SXT pulsations, spectra*
  - **Cyclotron lines in LMXBs vs. HMXBs: field decay?**
  - **Soft Gamma Ray Repeaters (SGRs) in LOCAL GROUP**

Mission Concept

Large Area, Wide Field, Broad Band Coded Aperture Telescopes



One of 2 EXIST telescopes: 2 x 2 array of 40º telescopes for combined FOV of 80º x 80º. CZT detector array and CsI shields/collimator shown.

Back -to - back 80º x 80º telescopes mounted at P3 site above truss on ISS for combined 160º x 80º FOV

~8m² imaging CZT, full-sky imaging each orbit ➡ >30-300X more sensitive survey at ~5-600keV; ~5-50" GRB & source positions

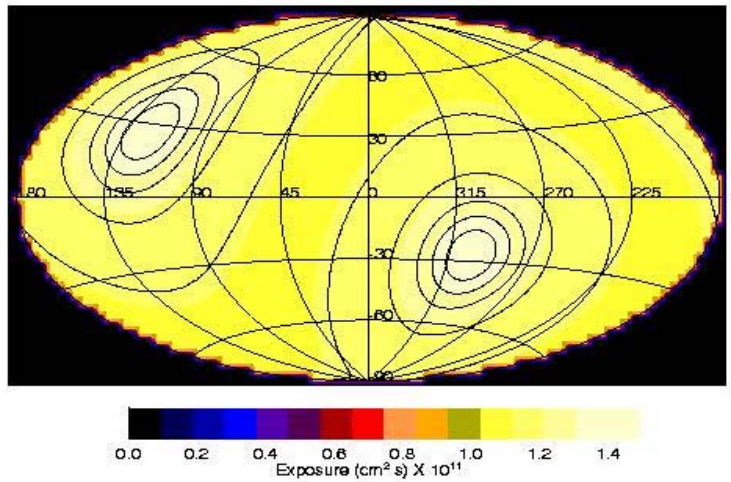
EXIST Overview

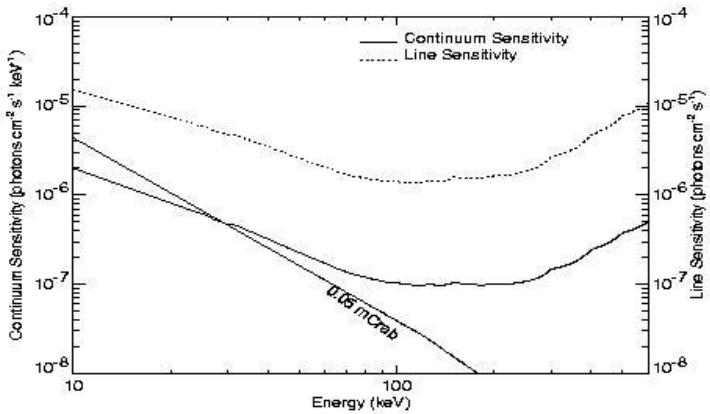
Mission Parameters (low -- high energy)

Energy range (resolution):	**5-100 (1) keV; 100 - 600 (3) keV**
FOV & resolution:	**160º x 80º; 2' - 6'**
Sensitivity (5σ):	**2mCrab --> 20mCrab/orbit**
(0.05mCrab=5x10^-13cgs)	**0.05mCrab --> 0.5mCrab/year**
Temporal resolution:	**1μsec --> ~30min; 90min -->1 year**
Telescopes/detectors:	**coded aperture/8m² CZT**

EXIST Exposure & Sensitivities

Exposure uniformity (6mo.)





Continuum and line sensitivities (6mo.)

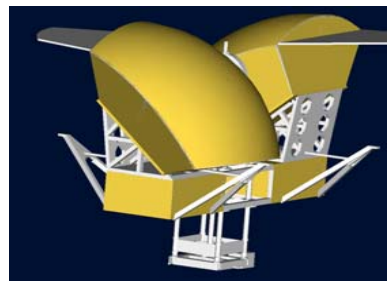
Progress over last year

Captured the interest of the broad astrophysics community

- ***Recommended as Moderate Mission in Decadal Survey***
- Expanded EXIST Science Working Group
- Presentations at meetings (HEAD, Gamma2001, etc.)

Mission concept engineering study (GSFC/ISAL) for ISS

- Telescope and detector design concept
- Initial ISS interface & background studies
- Formulation office established at GSFC



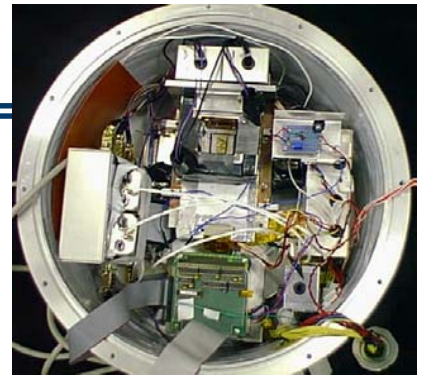
CZT imaging detectors & balloon flight tests

- Small prototype array & ASIC flown ("CZT2")
- Larger area prototypes & new contact studies

Balloon Flight Test of CZT/ASIC Imager Prototype

Harvard (EXITE2/CZT2) - MSFC (HERO)
Ft. Sumner, NM, balloon launch Sept. 19, 2000
(26 hr. flight to Colorado mountains!)

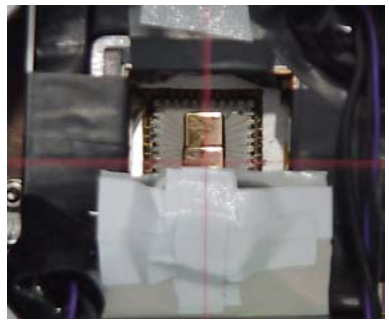
CZT2: Prototype CZT Tiled Array



CZT2 & data computer in press. vessel

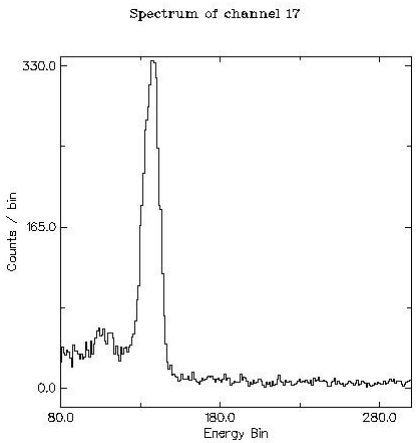
Test of CZT, pixellated array, and ASIC Readout: μEXIST

- eV Products vs. IMARAD CZT crystals (10 x 10 x 5mm)
- 4 x 4 pixel (2.4mm) arrays on each; tiled across flip-chip crystals
- at focus of capillary optic (~1cm²) to attempt direct "image" of Crab
- 40º x 40º passive/plastic shield collimator for EXIST field of view

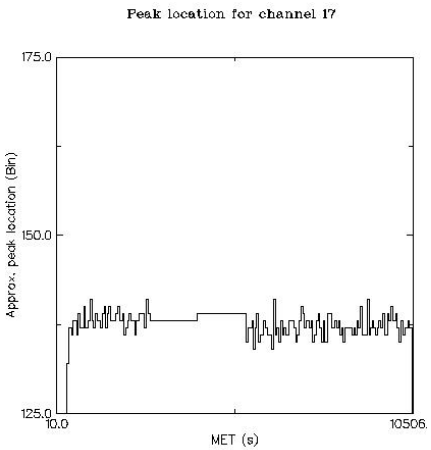


eV& IMARAD CZT in collimator
(Am-241 calib. source above)

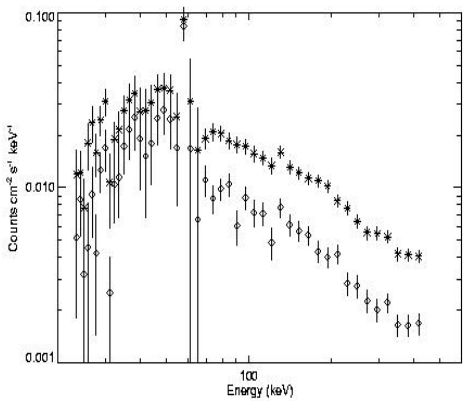
Preliminary Results:



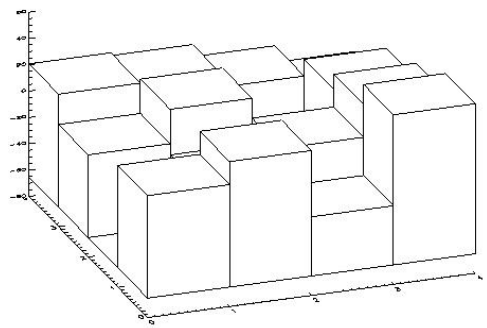
Am-241 continuous flight calib. spectrum (60 keV)



Gain vs. time (constant)



Background spectra: total (top) and after shield anti-co (bottom). Am-241 calib. spectrum not yet well subtracted below 60 keV.

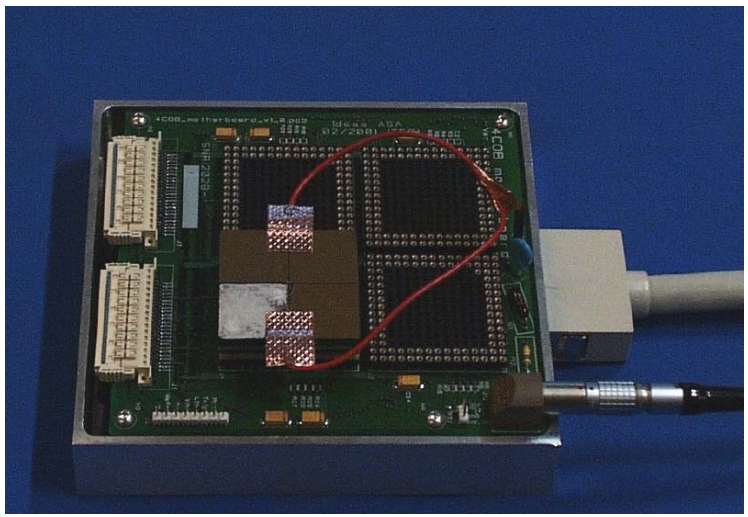


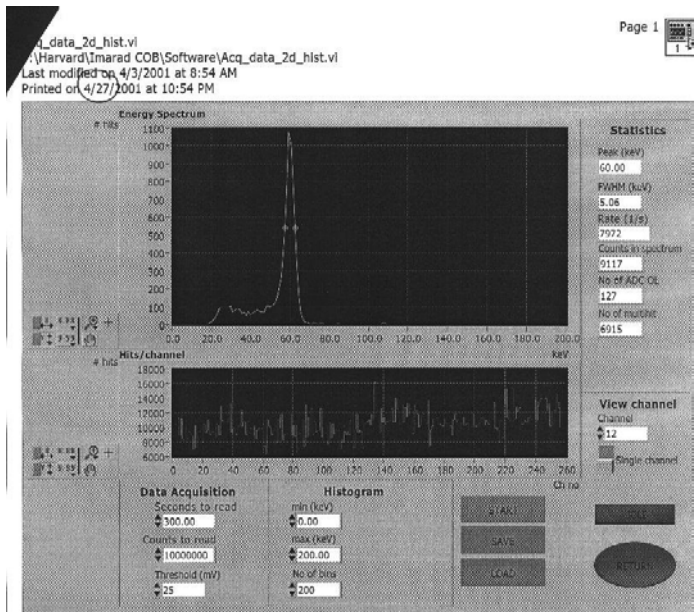
eV/CZT background image

EXIST

CZT3: Tiled "Large Area (64cm^2)" CZT Imager

- Fabrication of Imarad CZT 20 x 20 x 5mm crystals
- Development (with GSFC) of Pt contacts on Imarad CZT (low leakage current; Schottky barrier contacts)
- Development (with IDE) of 2 x 2 ASIC motherboard
- Passive/active collimator and shield; flight test May '01?





EXIST (*for Con-X*) Development Plans

GSFC/IMDC study of Free Flyer vs. ISS options

- Additional study of ISS option and mission trades (Sept. '01)
- Engineering study of free flyer mission design (Nov. '01?)
- Cost analysis of free flyer vs. ISS options

Schedule &cost for launch by 2009 (survey for Con-X)?

Discussions with potential international partners

- Continue discussions with Italian, German, UK groups

Fabrication/packaging CZT imaging detectors

- Continue development of optimum contacts

Imarad/Pt & passivation: HXT tech. dev.

- Studies of large-scale assembly/packaging
- Balloon flight test of prototype science imager (CZT2 or CZT3 with Imarad/Pt)